

MAD calculations for the short term solutions to mitigate the effect of extraction bumps in the Booster

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Several methods were suggested as a short term solution to mitigate the effect of extraction bump magnets:

1 - Using 3-magnet extraction bump (Figure 1) permits to decrease horizontal β by 7% and dispersion from 6 m to 5 m (Figure 2).

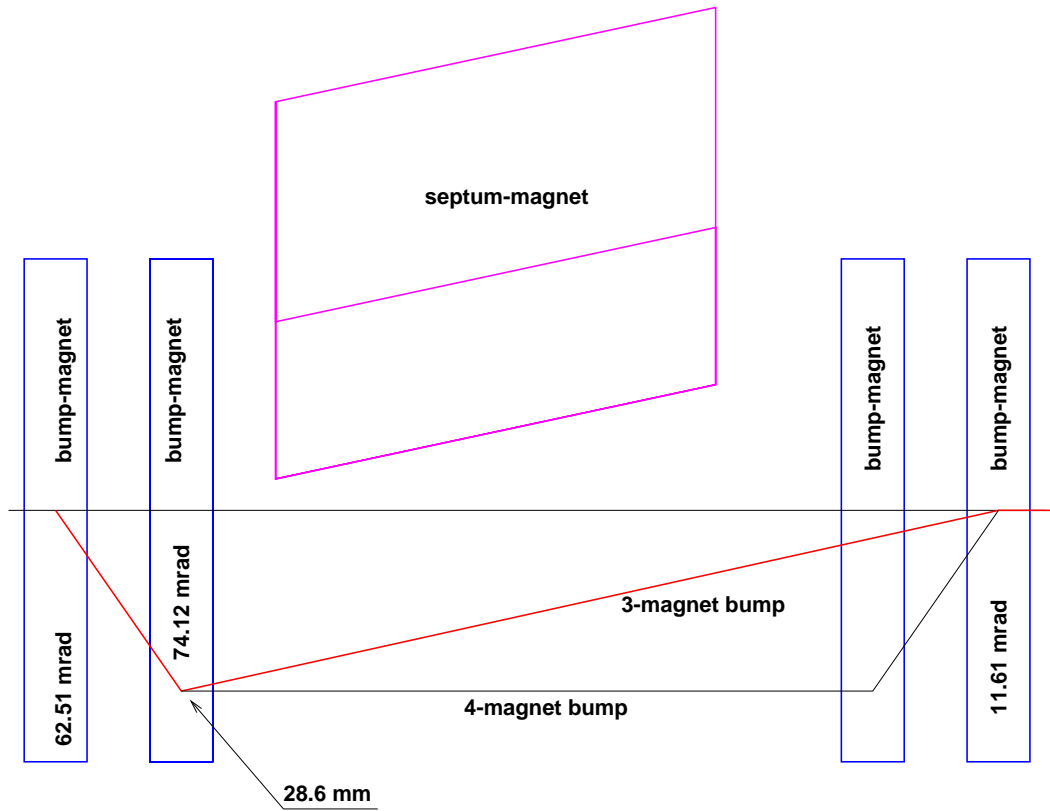


Figure 1: 3-magnet DogLeg bump.

The most effective way to mitigate edge focusing effect is based on the increasing distance between magnets, that permits to reduce bending angle (Figure 3). This allows to decrease horizontal β by 22% and dispersion by 42% if space is increased by 0.56 m (Figures 4, 5).

Maximum value of $\beta_{x,y}$ and dispersion at injection for different solutions of injection and extraction in the Booster are presented in Table 1.

| | $\Delta\beta_x$ | $\Delta\beta_y$ | ΔD |
|--|-----------------|-----------------|------------|
| without injection and extraction bumps | 100% | 100% | 100% |
| with existing injection and extraction bumps | 132% | 130% | 187% |
| without extraction bump at Long13 | 117% | 120% | 144% |
| 3-magnet extraction bumps at Long03 and Long13 | 132% | 120% | 156% |
| distance between magn. increase by 0.56 m at Long03 and Long13 | 104% | 120% | 115% |
| distance between magn. increase by 0.56 m at Long03 | 118% | 120% | 144% |
| new injection and extraction schemes | 106% | 115% | 106% |

Table 1: Maximum of β_x, β_y and dispersion at injection for different solutions of injection and extraction schemes in the Booster.

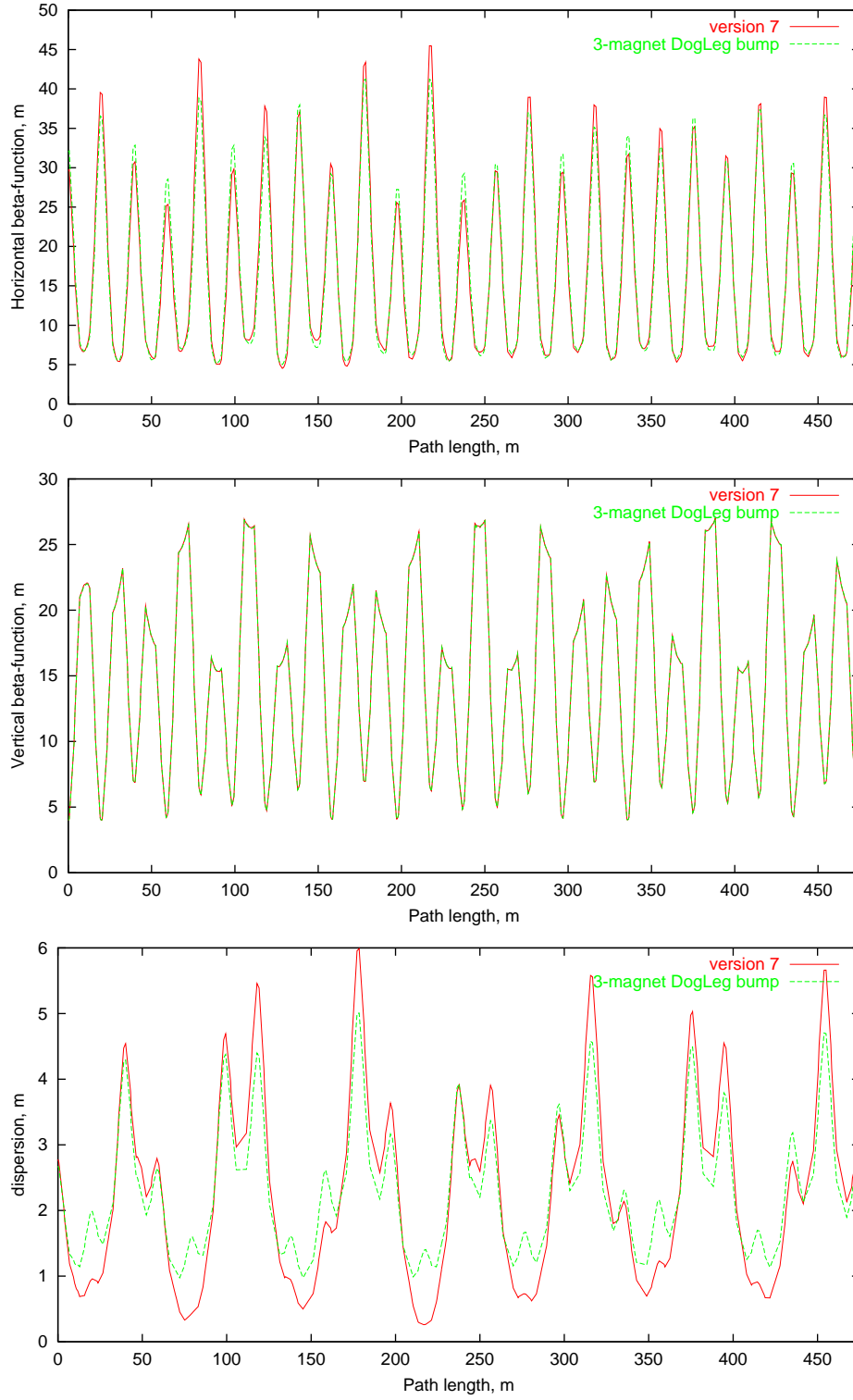


Figure 2: Fermilab Booster horizontal (top), vertical (middle) β functions and horizontal dispersion (bottom) at injection for with 4-magnet and 3-magnet DogLeg bump at Long03 and Long13.

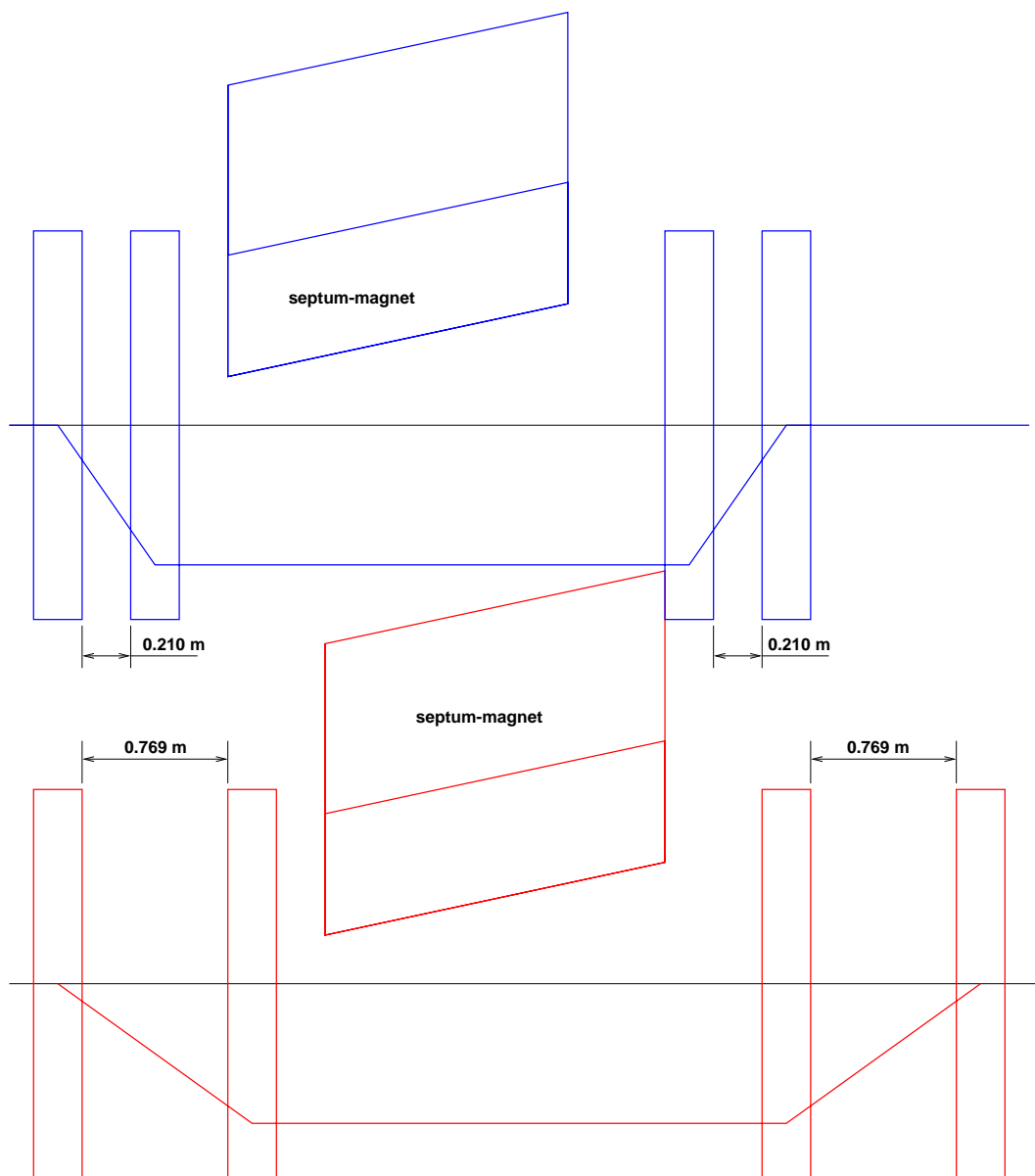


Figure 3: DogLeg bump with space between magnets increased by 0.56 m.

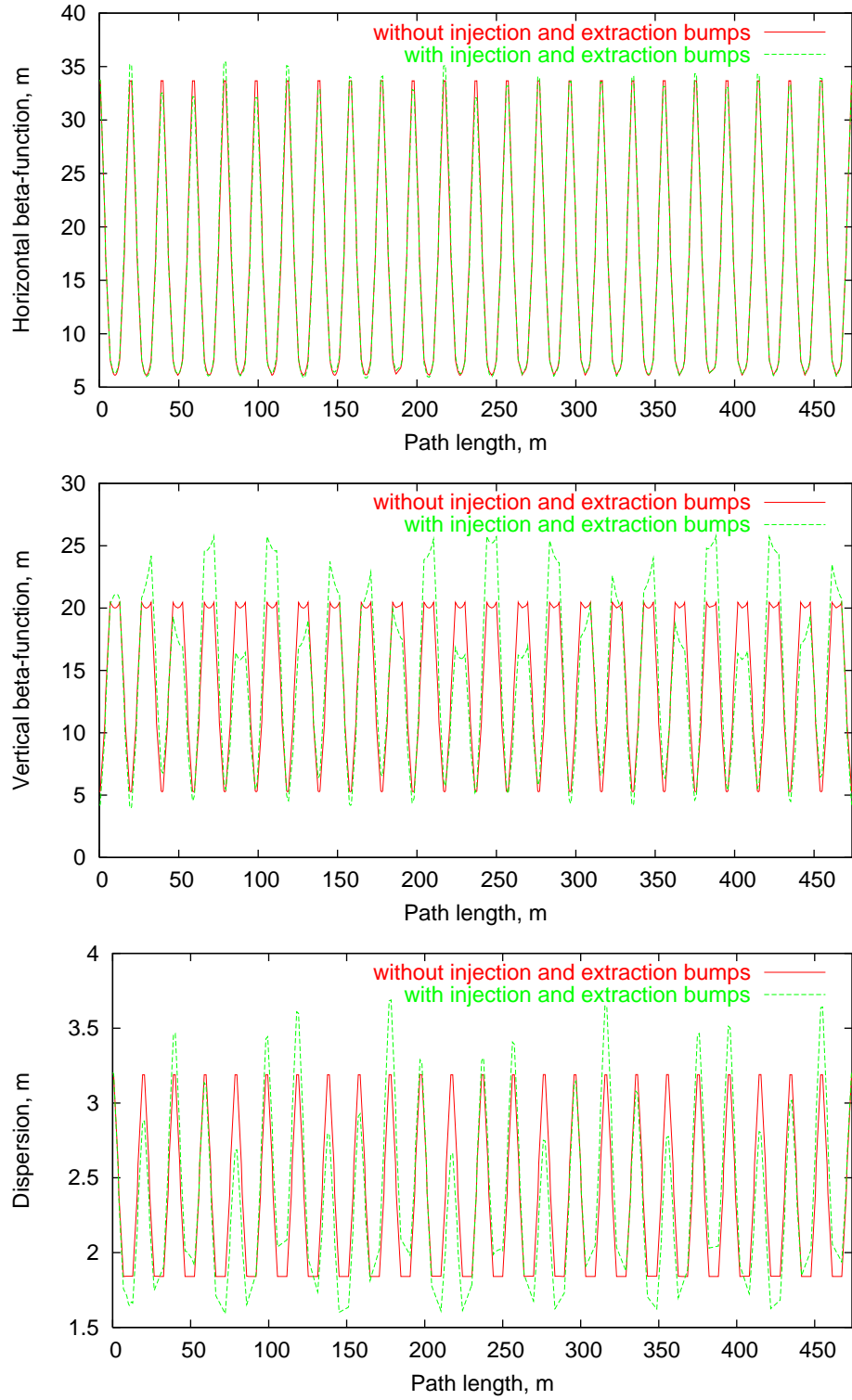


Figure 4: Fermilab Booster horizontal (top), vertical (middle) β functions and horizontal dispersion (bottom) at injection without injection and extraction bumps, and with injection bump and with DogLeg bump at Long03 and Long13 with space between magnets increased by 0.56 m.

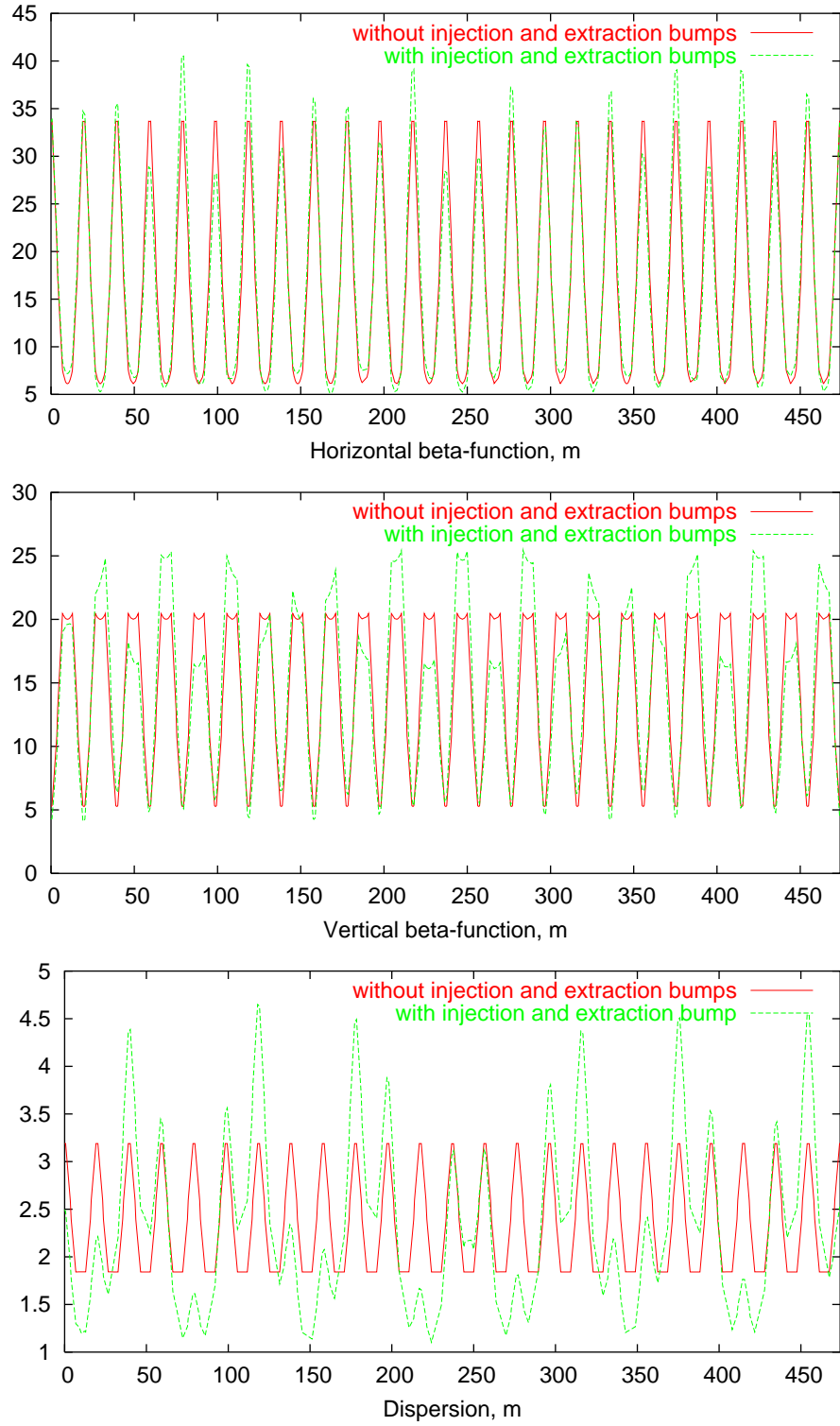


Figure 5: Fermilab Booster horizontal (top), vertical (middle) β functions and horizontal dispersion (bottom) at injection without injection and extraction bumps, and with injection bump and with DogLeg bump at Long03 with space between magnets increased by 0.56 m and old bump at Long13.